

# Notes on the page proof and publication of “Schallausbreitung in teilweise dissoziierten Gasen” by A. Einstein

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Recently, the [page-proof](#), with corrections, of Einstein’s publication<sup>1</sup> on the “Propagation of Sound in Partly Dissociated Gases”, which appeared in 1920 in the Proceedings of the Berlin Academy of Sciences, was found at the Instituut-Lorentz of Leiden University.<sup>2</sup> The last two pages of the proof are crossed out and replaced by a sheet in Einstein’s handwriting. In these notes, I briefly address the following two questions:

- Concerning the page proof, what is the difference between the contents of the crossed-out pages and the new page?
- Concerning the publication, are Eqs. (18,21,22) correct?

I start with the second question. The [scanned publication](#) provided by the Max Planck Institute for the History of Science in Berlin as part of the ECHO initiative (European Cultural Heritage Online), contains hand-made changes to Eqs. (18,21,22). After doing the calculations myself, I found these changes to be correct. The corrections affect the final result of the publication, the speed of sound  $V$ .

Regarding to the first question, the crossed-out pages deal with  $V$  in the special case  $RT \ll D$ , while the new page contains a more general result for  $V$ , not restricted to the regime  $RT \ll D$ . In addition, the crossed-out pages contain errors. The speed of sound  $V_{\text{new}}$  on the new page and the speed of sound  $V_{\text{old}}$  on the crossed-out pages are given by

$$V_{\text{new}}^2 = \frac{p}{\rho} \left( 1 + \frac{x_1^2 AB + R\bar{c}\omega^2}{x_1^2 B^2 + \bar{c}^2 \omega^2} \right), \quad V_{\text{old}}^2 = \frac{p}{\rho} \left( 1 + \frac{R\bar{c}\omega^2}{\left( x_1 \eta_1 \frac{D^2}{RT^2} \right)^2 + \bar{c}^2 \omega^2} \right), \quad (1)$$

<sup>1</sup>A. Einstein, *Schallausbreitung in teilweise dissoziierten Gasen*, Sitzungsberichte der Preußischen Akademie der Wissenschaften, Berlin, 8 April 1920, p. 380–385.

<sup>2</sup>Archived in the Leiden University Library, code number BPL 3545.

with

$$\bar{c} = \frac{C}{n_1 + n_2}, \quad (2)$$

$$A = \left( \frac{2D}{T} - \bar{c} \right) \frac{n_1}{n_1 + n_2} + R \left( 1 \pm \frac{4n_1}{n_2} \right), \quad (3)$$

$$B = \frac{D^2}{RT^2} \frac{n_1}{n_1 + n_2} + \bar{c} \left( 1 \pm \frac{4n_1}{n_2} \right). \quad (4)$$

(The “ $\pm$ ” refers to the error in Eq. (18): Einstein took the minus sign, it should be the plus sign.) Since both  $V_{\text{old}}$  and  $V_{\text{new}}$  originate from Eq. (18), we can compare  $V_{\text{old}}$  to  $V_{\text{new}}$  in the regime  $RT \ll D$ . The differences between the two are due to errors made in the calculation of  $V_{\text{old}}$  on the crossed-out pages:

- A factor  $\eta_1 + \eta_2$  has not been properly divided out in the transition from Eq. (18a) to the next equation. This accounts for the difference between  $x_1^2 B^2$  and  $\left( x_1 \eta_1 \frac{D^2}{RT^2} \right)^2$  in denominators in  $V_{\text{new}}$  and  $V_{\text{old}}$ , respectively.
- The term  $\bar{c}\omega^2$  in the denominator in  $V_{\text{old}}$  should be  $\bar{c}^2\omega^2$ . In the limit  $\omega \rightarrow \infty$ ,  $V_{\text{old}}$  takes the wrong value.
- The contribution  $x_1^2 AB$  to the numerator in  $V_{\text{old}}$  is ignored. This can be traced back to the transition from the intermediate equation between Eqs. (18a) and (19) to Eq. (19).

#### CONCLUSIONS:

- Concerning the page proof, what is the difference between the contents of the crossed-out pages and the new page? *Answer:*
  - The new page is a generalization of the crossed-out pages, which deal with a special regime.
  - The crossed-out pages contain errors.
- Concerning the publication, are Eqs. (18,21,22) correct? *Answer:*
  - Eqs. (18,21,22) are not correct. However, the scanned version with the hand-made changes is correct.